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# State-of-the-Art Summary of Incentives for Residential Water Conservation

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Water conservation programs are being discussed and implemented throughout the country. It appears, however, that unless there is a water crisis, these programs have little effect on domestic consumption. Why have water conservation programs been ineffective? What incentives exist for the individual homeowner to conserve water? This report addresses some programs and techniques that have been developed to encourage residential water conservation. Energy conservation techniques that appear to be directly relevant to water conservation have also been included. Specific areas covered are: consumer education and information programs, feedback techniques, possible incentives in mass-metered residences, and the impact of pricing on water consumption. An extensive bibliography is included.

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Jacqueline Elder

Center for Building Technology
National Engineering Laboratory
National Bureau of Standards
U.S. Department of Commerce
Washington, D.C. 20234

October 1980

Prepared for:
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Department of Housing and Urban Development
Washington, D.C. 20410

U.S. DEPARTMENT OF COMMERCE, Philip M. Klutznick, *Secretary*

Luther H. Hodges, Jr., *Deputy Secretary*
Jordan J. Baruch, *Assistant Secretary for Productivity, Technology, and Innovation*

NATIONAL BUREAU OF STANDARDS, Ernest Ambler, *Director*

ABSTRACT

Water conservation programs are being discussed and implemented throughout the country. It appears, however, that unless there is a water crisis, these programs have little effect on domestic consumption. Why have water conservation programs been ineffective? What incentives exist for the individual homeowner to conserve water? This report addresses some programs and techniques that have been developed to encourage residential water conservation. Energy conservation techniques that appear to be directly relevant to water conservation have also been included. Specific areas covered are: consumer education and information programs, feedback techniques, possible incentives in mass-metered residences, and the impact of pricing on water consumption. An extensive bibliography is included.

Key words: Consumer education; energy conservation; feedback; incentives; metering; rate structures; water conservation.

## PREFACE

This report is one of a group documenting National Bureau of Standards (NBS) research and analysis efforts in developing water conservation test methods, analysis, economics, and strategies for implementation and acceptance. This work is sponsored by the Department of Housing and Urban Development/Office of Policy Development and Research under HUD Interagency Agreement H-48-78.

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# 1. INTRODUCTION

"We can no longer expect an endless supply of cheap, clean water at the twist of a faucet" (Omang, 1980).*

Some areas of the country are currently experiencing water shortages. In other areas, communities are trying to cut down costs by delaying the construction of new or expanded sewage treatment plants. With increasing growth, many cities and towns are approaching storage and supply limitations. These limitations may mean that new customers cannot be provided with water and sewer service until supplies increase or demand decreases.

The costs of storing, supplying, and treating water are increasing. The cost of supplying water is directly related to the cost of energy. "The fastest growing cost item in the nation's water budget is the energy needed to pump water from one place to another" (Milne, 1976, p. 11). The individual homeowner experiences the relationship between energy costs and water costs when he uses hot water. The homeowner may pay more for the energy to heat the water he uses than he pays for the water itself (Milne, 1976).

For these and other reasons, water conservation programs are being discussed and implemented throughout the country. It appears, however, that unless there is a water crisis, these programs have little effect on domestic water consumption (Kudrna and Injerd, 1979). Why have water conservation programs been ineffective? What incentives exist for the individual homeowner to conserve water?

This report addresses some programs and techniques that have been developed to encourage residential water conservation. Energy conservation techniques that appear to be directly relevant to water conservation have also been included.

## 1.1 ORGANIZATION OF THE REPORT

Sections 2 through 6 each consider a program or technique which might encourage water conservation.

In many instances, the consumer lacks information about how much water particular appliances use or how daily habits affect water consumption. Section 2 looks at education and information programs which have been developed to address these issues.

Energy conservation studies have shown that providing an individual with knowledge (feedback) of the rate at which he is consuming energy will often encourage a reduction in energy usage. The implication of this area of research for water conservation is explored in Section 3.

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* The references are given, by Section, in Section 8.

Individuals living in mass-metered residences do not directly experience the consequences of consumption in the form of a water bill. Possible incentives to encourage conservation among this group are discussed in Section 4.

Section 5 looks at other research that has been conducted on possible incentives for conservation.

Section 6 examines the impact of pricing on water consumption.

## 1.2 SCOPE OF THE REPORT

This report covers incentives for residential water conservation. Information was obtained from various sources ranging from published reports to individual discussions. An extensive literature review was undertaken, initially concentrating on utility company and water-related publications and finally expanding to include relevant energy conservation and psychological studies.

Since most of the experience and information concerned with motivating people to conserve water and, to a lesser extent, energy, is quite recent and has not yet been published, a substantial portion of the information provided in this report was obtained through personal interviews with utility company representatives, state and local officials, and individual researchers.

The examples of programs and materials provided throughout the report are by no means exhaustive, but are meant instead to be representative of the types of programs currently being developed and implemented. Many of these programs have been undertaken without systematic evaluation of their effects and do not have quantitative results associated with them.

# 2. CONSUMER EDUCATION AND INFORMATION

Page (1977), stated that "the parallel is inescapable: Like energy, water is an environmental problem, a technological problem, and an attitudinal problem" (p. 9). Consumer education programs are aimed at changing attitudes and behaviors; they are based on the premise that individuals will change their water-wasting habits once they are made aware of them. A readership questionnaire in the August 1978 issue of Communicator found that most of the respondents thought public education was the fairest way to achieve conservation (Meyer, 1978).

Consumer education programs have been developed and implemented by utility companies, government agencies, and consumer and environmental groups. The most extensive and widely known programs have been developed by the utilities.

James Lattie, Public Information Officer of the East Bay Municipal Utility District (E.B.M.U.D), discusses the objectives of consumer education programs.

"For a drought-related public information program, the goals are fairly specific: Thorough public understanding of the nature and extent of the problem; awareness of how the regulations of a rationing or restriction program will affect individual customers; understanding of what customers can and cannot do to meet the requirements; what the economic costs will be to them, particularly including some understanding of why the water bill does not go down when the consumption goes down. There will also probably be a number of peripheral things the public should know or will want to know, such as the relationship between energy and water conservation, how to read a water meter, how to understand the information on their bill more completely, and how to look for 'leaks'" (Lattie, 1977, pp. 46 and 47).

If there is no immediate water crisis, officials may want to consider a long-range continuing program with the following goals: "increased public awareness of the nature of domestic water supply systems and the complexity of the problems they face in meeting the demand for water; recognition of the desirability of water conservation; understanding of the economic and other costs and consequences of alternatives to water conservation; and perhaps other areas of concern as appropriate to individual water agencies..." (Lattie, 1977, p. 46).

Lattie (1977) summarizes by emphasizing the following:

"It does not matter what kind of voluntary program is requested, what kind of mandatory program is ordered, or what rate schedule is adopted, if it is ineffectively communicated to the public, it will be an ineffective program" (p. 46).

Whether a public information program is in response to an immediate crisis or a long-range need for water conservation, according to Lattie there are three means of informing the public: direct mail, news media, and personal contact. Direct mail programs include inserts with the regular bill or a newsletter which may be mailed with the bill or separately. A separately mailed newsletter has the disadvantage of requiring additional postage, but the advantage that it can be sent to consumers who are not customers, such as apartment residents. News media programs include news releases, public service announcements, and press conferences. Personal contacts range from telephone calls to plant tours, speakers for school and service organizations, community meetings, task forces, and special events such as "Camel Day" in which the Washington Suburban Sanitary Commission asked customers to conserve as much water as possible in a 24-hour period.

Utilities should consider employing a variety of programs since no one program will reach all the people. Lattie also emphasizes that the cost of different programs will vary depending upon a number of factors, but he has developed the attached table as a guideline (see Table 1).

Table 1: MATERIAL DESIGN AND PRODUCTION COSTS*

| Printed Materials | Design | Printing | Quantity |
|---|---|---|---|
| Newsletter | $ 100-500 | $ 25-300 | 1000 |
| Bill Inserts | 200-700 | 6- 25 | 1000 |
| Slogan Stickers | 300-700 | 16- 20 | 1000 |
| Lapel Buttons | 50-400 | 70-100 | 1000 |
| Truck Decals | 50-200 | 1- 1.30 | each |
| Key Chains | 100-400 | 130-200 | 1000 |
| Litter Bags | 50-400 | 50- 55 | 1000 |
| Matchbooks | 0-100 | 13- 16 | 1000 |
| Posters | 300-700 | 80-100 | 1000 |
| Bus Posters | 300-700 | 20-100 | 1000 |

| Broadcast Materials | Production | Per Print |
|---|---|---|
| Television Public Service Announcement/30 seconds | $ 400-15,000 | $ 8-12 |
| Radio Public Service Announcement/30 seconds | 50- 200 | 1.50 |
| Motion Picture/10 minutes | 5000-25,000 | 50-100 |

*Source: Lattie, J., Public education for water conservation, in Community Water Management for the Drought and Beyond: A Handbook for Local Government, California: The Governor's Office of Emergency Services, July 1977.

Many consumer education programs have been developed to encourage water conservation. Some of these programs are the direct result of an immediate water shortage; others are based on a perceived long-range need for conservation.

## 2.1 RESPONSE TO IMMEDIATE SHORTAGE

Perhaps the best known example of a consumer education program developed in response to an immediate crisis occurred in northern California. During the water shortage in northern California in early 1977, both voluntary and mandatory conservation programs were instituted. Mandatory conservation usually involved either a mandated percentage reduction from the previous year's use, or a quota, expressed in gallons per day per person or per household.

In conjunction with mandatory restrictions, outdoor water use was restricted and landscape use was banned or limited to early morning or early evening on specified days. One hundred and fifty communities were ultimately under mandatory conservation, representing 1/3 of California's population or 6 1/2 million people.

In addition to these programs, the California Department of Water Resources (DWR) established a drought information center which provided the following four basic services:

(1) answer telephone inquiries

(2) respond to written communications

(3) document the drought and mitigative measures

(4) maintain contact with other agencies concerned with the drought.

DWR also set up a speaker's bureau, published a drought bulletin, and coordinated the distribution of water conservation kits. DWR began a statewide water conservation education program in cooperation with the State Department of Education and local water suppliers and schools (see Section 2.3).

Another example of response to the drought is provided by St. Helena, California. St. Helena developed a program to encourage individual conservation. The program consisted of the following elements:

° The local newspaper and radio station publicized reservoir capacity, average daily use figures, and needed cutbacks.

° The Public Works Department distributed water conservation kits containing dye tablets for checking for toilet tank leaks, plastic bottles used to displace water in the toilet tank, and showerhead flow restrictors.

° The Public Works Department encouraged large water users (wineries, other business, schools) to make significant cutbacks in water consumption.

Water use was reduced 47 percent and the city saved $140 a day in water purchase costs (Page, 1977).

As a result of the California experience, John Nelson (General Manager, North Marin County Water District) stresses the need for consumer education during a crisis: "Of all the debate that has gone on regarding the various rationing programs, most utilities that have gone through it agree on one key point; namely, rationing can only be achieved through the voluntary commitment of the consumer, and to earn that commitment, the utility must communicate the shortage problem and required rationing solution to the consumer via the media in a lucid and truthful fashion" (Nelson, 1979, p. 2).

## 2.2 LONG-RANGE PROGRAMS

Long-range programs are often aimed at developing a "conservation ethic." By fostering conservation, officials hope to ultimately defer or eliminate the expense of expanding supply, storage, and treatment facilities.

David Farrell (Coordinator, Illinois Interagency Water Management/Conservation Committee) describes the purpose of the Illinois water conservation program as not just to change behavior (which may serve as only a short-term solution), but to change the circumstances in which behavior occurs. Farrell emphasizes that when there is not a water crisis, most individuals will forget about conservation and return to old consumption patterns. Farrell hopes to encourage people to make hardware changes that will save water even when conservation is not an issue.

To help make it realistic for people to change the circumstances of water use in their homes, Farrell is urging the retail hardware industry to stock a variety of low-cost devices, new and retrofit, that reduce flow on faucets, in toilets, and on showerheads.

In the state of Illinois, public education activities have included: distribution of bumper stickers, distribution of instructions for detecting leaks in toilets, presentations, regional conferences, dissemination of a pamphlet giving reasons for water conservation.

Madison, Wisconsin also has a long-range conservation program -- one based on long term fiscal planning. "Analysis showed that by postponing construction of certain supply facilities and by postponing certain electrical demand costs, customers could save substantially with only minor inconvenience" (Deibert, 1978, p. 2). In 1975, a conservation program was initiated to shift the lawn sprinkling load to off-peak hours. The necessary information was communicated in a number of ways: displays, school talks, hose tags, bus posters, billboards, radio and television spots, brochures. The effect

of the program was to lower demand during peak evening hours, thus allowing the existing system to meet current demands as well as demands anticipated in the near future.

A sewer crisis prompted a water-saving program by the Washington Suburban Sanitary Commission (WSSC). WSSC compiled a handbook on ways to save water and reduce waste and distributed the handbook by mail to its customers. A similar handbook was designed for apartment dwellers. Other conservation activities have included: workshops for property managers, presentations to civic and service organizations, compilation of product data on water-saving appliances, television and radio spots, and a field test to determine the performance of retrofitted water conservation devices. (See Section 2.5 for a description of this study.) In addition "Bottle-Leak Detection Kits" were distributed. The kit contained three plastic quart bottles for water displacement in the toilet tank, two dye tablets for making a leak check of toilets, and an instruction booklet informing customers how to use the bottles and the dye tablets and also providing water-saving hints. Since then, WSSC has made available shower control insert devices that reduce shower flow to 3 gallons per minute (gpm). The kit was offered to customers through a flyer in the water-sewer bill. Most recently, a handbook on outdoor water use, "Keeping the Garden Green" has been distributed. Officials at WSSC stress that the rewards of their program result not only from reduced water usage but also from increased consumer awareness of water as a limited and valuable natural resource.

## 2.3 SCHOOL PROGRAMS

School programs are an important component of many long-range water conservation programs. The developers of school programs hope that the children will take the knowledge they have gained at school and apply it at home, thereby influencing their parents.

One example of a school program is provided by the East Bay Municipal Utility District (E.B.M.U.D.) in California. In 1972, E.B.M.U.D. initiated Project WATER (Water Awareness through Education and Research). The program is aimed at elementary and secondary school children and attempts to foster an understanding of the role of the water utility as well as an awareness of the economic and environmental costs of supplying water. Materials have been developed for students at the following levels:

Primary Level -- "Water Play" is a 16-page color booklet of classroom games and activities stressing an awareness and appreciation of water.

Upper Elementary Grades -- "Water, Where It Comes From and Where It Goes" is a booklet aimed at developing an awareness of water by employing a low-keyed approach to understanding the water supply system. Also developed for this level is "The Official Captain Hydro Water Conservation Workbook," a 32-page workbook using a comic book format and featuring the heroic Captain Hydro battling the Water Bandit. The workbook begins by

introducing water and water conservation and then is divided into four curricular segments: mathematics, science, social science, and the humanities and the arts.

Secondary Level -- Three publications have been developed for this level; each employs a news magazine format and focuses on problem solving in one curricular area. "Water Conservation in the Community" covers the social sciences, "Water Conservation Through Science" emphasizes the scientific aspects of drought, and "Water Conservation at Home" includes the areas of home economics and industrial arts.

The materials mentioned above are distributed only to teachers and administrators who specifically request them. In addition to these curricular materials, E.B.M.U.D. has developed supplementary materials (films, buttons, posters, etc.) and conducts filter plant tours stressing water conservation.

Other states and localities also have school programs, one of the most extensive being in the state of Illinois.

## 2.4 FIELD STUDIES

Field studies have been undertaken in response to crisis situations and as a part of long-range consumer information programs. Results have been mixed and often difficult to measure due to a number of uncontrolled variables.

The Marin Municipal Water District in California distributed water saving kits in the form of "doorknob hangers." Each kit contained a low-flow showerhead (to reduce flow to 3 gallons per minute), two 1-quart toilet-tank displacement bottles (used together they saved 1/2 gallon of water per flush), leak detection dye tablets, hints on finding and repairing leaks, hints on home irrigation, and other literature illustrating possible savings.

These kits were distributed by teams of male/female college students dressed in blue pants and white shirts with the legend "Water Conservation Team." The team would install the devices at the consumer's request. A 20 percent sample survey at the conclusion of the program indicated that the showerheads were being used in 40 percent of the homes and the bottles in 60 percent.

In 1977, the California Department of Water Resources conducted several pilot studies to determine the effect of toilet dams and shower restrictors on water and energy consumption, to determine the most successful and cost effective means of distribution, to evaluate the relative metits of offering the devices free or selling them, and to measure public acceptance of the devices. Table 2 describes the pilot programs undertaken.

These pilot studies yielded the following results:

Table 2. DESCRIPTION OF PILOT PROGRAMS*

| Pilot Area | Type of Community | Number of Households | Water Supply Condition | Method of Kit Distribution | Free/ Purchase | Type of Promotion Campaign |
|---|---|---|---|---|---|---|
| San Diego Metropolitan Area | Urban | 370,000 | No rationing | Mass; door-to-door with personal contact, depot | Free | Information post cards, paid ads, public relations activities |
| Santa Cruz County | Urban and rural | 60,400 | 45 percent of County had rationing ordinances to achieve up to 30 percent reduction | Depot and home delivery with free installation upon request | Free | Public relations activities, home canvassing |
| City of Sanger | Small agricultural community | 3,000 | No rationing | Home delivery upon request | Free | Information post cards |
| El Dorado Irrigation District | Small urban and rural | 15,300 | Pricing structure and rationing ordinance designed to achieve 50 percent overall reduction | Depot | Purchase | Leaflets, paid ads in newspapers, public relations activities |
| City of El Segundo | Urban | 6,000 | Water rationed; ordinance designed to achieve 10 percent reduction | Mobile sales depot | Purchase | Paid ads in newspapers, mass mailing newsletters |
| Community of Oak Park | Small suburban | 753 | No rationing | Free installation service | Free | Public relations activities |

* Source: A Pilot Water Conservation Program, Bulletin 191, Sacramento, California: Department of Water Resources, October 1978.

"In San Diego, the most cost effective way (the most savings per program dollar) was to hang free device kits on each doorknob. The depot method, in which residents could pick up free devices, was a close second in cost effectiveness. However, the depot method included a substantial amount of free labor that -- if included -- would have made depots much less cost effective.

"Overall devices were well received. Projecting the results of the best device (dams) and best method (mass distribution in San Diego), a 35 percent installation rate can be expected for toilet devices and a 10 percent rate for shower restrictors, given similar attitudes and conditions" (A Pilot Water Conservation Program, p. 8).

In 1972, the Washington Suburban Sanitary Commission (WSSC) initiated the Cabin John Drainage Basin Project to evaluate the effectiveness of several commercially available water-saving devices. Over 1000 single-family homes were involved in the four-year study. Toilet insert devices were placed in each of the homes (four different types were used) and 3-gallon per minute shower flow control devices were placed in an additional 25 homes. The homeowners also received various WSSC publications stressing water conservation. Meter readings for the area indicated a statistically significant reduction in water use over the four-year study period.

At the conclusion of the study, a questionnaire was mailed to 100 randomly selected single-family homes. The responses indicated that "significant numbers of the toilet insert devices were removed by the homeowners in the four years following their installation... Reasons for the removal of the devices varied, but in all cases the necessity of flushing the toilet twice to remove solids was the principal complaint" (Sharpe and Smith, 1978, p. 95). Even though a large number of devices were removed, the data still indicated a significant reduction in water use. "This reduction can be attributed to a change in water using habits to use less water... Reduction of lawn and garden irrigation is clearly the most frequently mentioned habit change while doing only full loads in clothes and dishwashers, taking shorter showers, and repairing leaks were mentioned frequently..." (Sharpe and Smith, 1978, p. 96).

## 2.5 EFFECTIVENESS OF CONSUMER EDUCATION PROGRAMS

How effective have these consumer programs been?

The evidence seems to support the short-term effectiveness of consumer education programs especially in crisis situations. Hoffman, Glickstein, and Liroff (1979) assessed institutional and consumer response to measures taken to mitigate the effects of the drought in California. A key finding was the fact that "research indicates that the willingness of residential, and to a less extent commercial and industrial, customers to restrict their water consumption is influenced more by the degree to which they believe there is a shortage requiring conservation than by any other factor" (p. 360). The researchers cite three reasons as to why Bay area residents believed in the necessity for conservation. First, from past

experience and knowledge of weather patterns, residents believed in the possibility of drought and, photographs of reservoirs made the water shortage highly visible. Second, the behavior of the water suppliers was consistent with the existence of a drought and finally, stories by the news media reinforced the seriousness of the drought.

The authors also concluded "that large-scale reductions in water use were achieved even in cases where more than 50 percent of the water district's customers perceived the district's rationing policies as fundamentally unfair. Hence, it would seem that once the public is convinced there is a shortage, they will conserve whether they feel the rationing plan is fair or not" (p. 361).

Finally, the authors emphasize that "behavioral changes...were thought to be three to four times as effective as structural devices in lowering residential consumption during the drought" (p. 362).

Although the California program was extremely effective, only time will indicate the long-term effects.

Many of the communities with long-term conservation programs have cited successful outcomes. Elmhurst, Illinois was able to avoid the expense of sinking a new deep well. Madison, Wisconsin was able to shift outside water use to off-peak hours thus enabling the postponement of major construction. Representatives of the Washington Suburban Sanitary Commission emphasize that consumer education programs do not always have an immediate impact, but may serve to foster a conservation ethic which will encourage individuals to pay increasing attention to water-use habits. School programs are certainly aimed at long-range awareness.

Kudrna and Injerd (1979) provide a more negative point of view, "...overall the impact of adult water conservation education in Northeastern Illinois has probably been minimal. Our conclusion is that an effective adult water conservation education program, without an attendant water shortage crisis, is very difficult, if not impossible, to accomplish" (p. 7).

Finally, in evaluating these programs, we should bear in mind the question asked by Grear (1975). "Where do we go from here on the national level? Do we promote a national education campaign aimed at changing human behavior (water consumption behavior) and promoting the retrofitting of "band-aid" type water saving appliances, or do we go with plumbing and housing code changes requiring the installation of the most efficient water conserving plumbing devices such as aerator faucets, shower flow control devices, water saving toilets, or flush valve toilets in all new housing?" (p. 6).

## 3. FEEDBACK

For whatever reason an individual wishes to conserve water, it is difficult for him to do so without information about his rate and pattern of

consumption. Consumer education materials (see Section 2) provide some of this information in broad, general categories. Feedback techniques provide more personalized information.

Feedback is a process of providing an individual with data, information, or other appropriate "signals" about his performance in a particular area, in this case in the area of water or energy consumption. The information about performance provides the basis for possible changes in behavior, i.e., alteration of consumption patterns.

The water bill is a form of feedback, although the information provided by it is probably too general and too far removed in time from the actual consumption to enable the consumer to effectively alter his water use. The water meter (see Section 6.1) can provide more immediate feedback, but is often not readily accessible and probably does not give specific enough information to enable the consumer to determine the effects of particular devices or habits on consumption.

Feedback or knowledge of performance is one of the incentives that may be adopted to encourage water conservation. The psychological literature indicates that an individual's performance improves when information is given about that performance. In addition, research in energy conservation has employed feedback with some encouraging results which should apply fairly directly to the area of water conservation.

## 3.1 THE PSYCHOLOGICAL LITERATURE

For some time now, psychologists have been investigating the influence of knowledge of performance on performance. "In general, research on the problem of knowledge of performance involves determining the effects of giving or withholding various kinds of information about performance during and for varying amounts of time after that performance" (Ammons, 1956, p. 279). The variables which have been studied include: type of feedback (verbal, written), at what time during or after performance feedback is most effective, effect of withdrawal of feedback, and interaction between feedback and goal setting.

Ammons (1956) reviewed the psychological literature on feedback and summarized the findings in several statements which he labels "generalizations." The generalizations which are relevant to the area of conservation include:

° "The performer usually has hypotheses about what he is to do and how he is to do it, and these interact with knowledge of performance" (p. 281). This generalization indicates that even if the consumer is given accurate information about his water consumption and is motivated to conserve, he needs to be given information and/or training on actual conservation techniques.

° "For all practical purposes, there is always some knowledge of his performance available to the human performer" (p. 281). Even if the

consumer does not have his water consumption individually metered, he has some information which will help him determine his water consumption and indicate ways in which he can lower it.

° "Knowledge of performance affects rate of learning and level reached by learning. Almost universally, where knowledge of their performance is given to one group and knowledge is effectively withheld or reduced in the case of another group, the former group learns more rapidly, and reaches a higher level of proficiency" (p. 283). This generalization suggests that no matter what means is used to encourage conservation, that means will be enhanced if it is combined with feedback information.

° "Knowledge of performance affects motivation. The most common effect of knowledge of performance is to increase motivation" (p. 285). Motivation is the key to conservation. If feedback increases motivation it may well become a major element in conservation programs.

° "The more specific the knowledge of performance, the more rapid the improvement and the higher the level of performance. Other things being equal, the more exactly a subject knows how he has performed, the more likely he is to be able to make appropriate corrections" (p. 287). The gross consumption figures recorded on the water bill probably do not give the consumer specific enough information about which habits and devices may be using the most water to enable him to effectively alter his water usage patterns. The consumption figures registered on the water meter may also be too general to provide effective feedback.

° "The longer the delay in giving knowledge of performance, the less effect the given information has" (p. 287). Again, the water bill which usually arrives quarterly is probably not sufficient to encourage conservation.

° "When knowledge of performance is decreased, performance drops. Whether the drop would bring the performance back to the same level as that if this lesser degree of knowledge of performance had obtained all along cannot be ascertained..." (p. 290). This generalization suggests that it probably is not practical to provide feedback for a short period of time with the expectation that the positive results will continue after the feedback is discontinued.

° "Where subjects are not being given supplementary knowledge of performance by the experimenter any longer, the ones who maintain their performance level probably have developed some substitute knowledge of performance" (p. 292). If continuous feedback is not possible, it is important to determine what substitutes can be developed.

Finally, Ammons raises the question of what is actually meant by knowledge of performance. "Does it mean just to make the stimuli available to the subject? Or does it imply something about training him to use the available information?" (p. 293). These questions have been dealt with in some of the feedback studies in the area of energy conservation.

## 3.2 ENERGY CONSERVATION RESEARCH

Ammons (1956) stated that "when the psychologist experiments with knowledge of performance, he ordinarily sets up a situation in which he compares the learning of a task or performance changes by a group which receives relatively more information about how it is carrying out the task with the learning or performance of another group which receives less information" (p. 279). Most of the feedback and energy conservation research has been carried out by psychologists and most of the research quite closely follows the format described by Ammons.

Seligman and Darley (1977) reported a study in which homeowners, in physically identical interior townhouses, were given daily feedback on electricity consumption. Feedback was expressed as a percentage of actual consumption over predicted consumption (based on previous consumption corrected for weather conditions) and this figure was displayed in a case outside the homeowner's kitchen window. The results indicated that giving homeowners daily feedback on their rate of electricity usage was effective in reducing electricity consumption by about 10 percent. As Seligman stresses, the study raises a number of questions which need to be answered before feedback can be considered as an effective incentive for conservation. "How frequently should feedback be given? Who should compute and record the feedback, the people themselves or some outside agency? How salient does the feedback need to be? Does conservation of electricity stimulated by a feedback procedure generalize to other uses of energy... How long will the effects of feedback persist after the feedback has ceased? Will displaying the feedback in dollars and cents be more effective than other modes of information presentation?" (p. 367).

Ramey-Smith and Gagnon (1979) dealt with one of these questions in a laboratory study which looked at consumer response to cumulative (a running accumulation of the cost of energy consumed), instantaneous (current rate used to estimate future cost), and projected (previous day's energy cost used to estimate future cost) feedback, each presented as dollar and cents values. Each type of feedback was presented on an hourly, daily, and weekly basis. Subjects indicated a preference for all time periods of cumulative feedback. Subjects noted that hourly instantaneous feedback was useful in providing information about the energy consumption of individual appliances, but stressed that this information could be provided by sources other than a feedback device.

Seaver and Patterson (1976) investigated the effects of feedback and feedback with commendation on homeowners' consumption of fuel-oil. Feedback consisted of a slip which accompanied the fuel-oil bill and showed the customer's rate of use compared with the previous winter's rate of use. Feedback with commendation provided those customers who reduced consumption with a decal on which the words "WE ARE SAVING OIL" were printed. The feedback plus commendation group had a significantly lower consumption rate than either the feedback group or a control group receiving neither feedback nor commendation. The feedback group and the control group showed similar consumption rates.

While Seaver and Patterson have shown that commendation combined with feedback can lead to conservation, other researchers have argued that feedback is not effective unless it is combined with goal setting or with financial incentives.

## 3.3 FEEDBACK AND GOAL SETTING

In a study by Becker (1978), the researchers concluded that feedback is not effective unless it is accompanied by a serious conservation goal. Some homeowners were asked to reduce electricity consumption by 2 percent, while others were asked to achieve a reduction of 20 percent. Feedback was provided to both groups three times a week. The group that received both feedback and the more difficult goal used 13 percent less electricity than a control group that was given neither a goal nor feedback. The 2 percent feedback group did not differ significantly from the control.

## 3.4 FEEDBACK AND FINANCIAL INCENTIVES

Kohlenberg et al. (1976) reported a study in which feedback plus financial incentives (a rebate of double the monetary value of the electric bill for a 100 percent reduction in peaking) was found to be more effective (peaking was reduced about 50 percent) than information or feedback alone in reducing electrical energy use during peak periods by residential customers. The researchers also found that removing the experimental conditions caused energy use to return to patterns exhibited before the experiment began. The researchers used families who belonged to a conservation club and stressed that even with the families' obvious motivation to save, daily patterns represented strong habits and consuming behavior was resistant to change.

Winett and Nietzel (1975) studied the effects of information (manual containing energy reduction suggestions), feedback (self-recording form for monitoring weekly meter readings), and payments (up to $5 per week for reductions greater than 20 percent) on the consumption of electricity and natural gas in private residences. One group received information and feedback while another received information, feedback, and monetary payments. Both groups reduced electricity and gas consumption; the monetary payments group showed a greater reduction in electricity use. (It should be noted, however, that both groups received some form of monetary payment since reduced consumption resulted in a lower utility bill.)

Winett et al. (1978) assigned volunteer households to one of five experimental groups: A high rebate group in which participants received conservation information, weekly written feedback on their electricity use, and were eligible for monetary rebates of 30 cents for each 1 percent reduction in weekly kilowatt-hours of electricity used compared to average use during the previous summer; a low rebate group which was the same as the high rebate group except rebates amounted to 1.3 cents for each 1 percent reduction; a weekly feedback group in which participants also received information but not rebates; an information group; and a control group. The high rebate group reduced electricity use by about 12 percent over the course of the study.

The low rebate group reduced consumption only slightly, the feedback and information group showed no change, and the information only group showed an increase in use.

Hayes and Cone (1977) employed monetary payments (a maximum of $15 at the end of one week for a 50 percent or greater reduction in electricity use), energy information (a poster describing ways to reduce consumption and indicating the electricity consumption of household devices), and daily feedback (a flier showing amount of electricity consumed the previous day, cumulative consumption for the week, projected consumption for the week, percent above or below baseline represented by the projected figures) to reduce electricity consumption in a student housing complex. The results indicated that monetary payments for reduction of energy use were more effective than feedback or information. Information had only a temporary effect which was no greater than telling subjects their use was being monitored. This finding is particularly important in light of the fact that utility companies and local governments seem to rely heavily on information dissemination and consumer education to encourage conservation.

### 3.5 FEEDBACK AND WATER CONSERVATION

McClelland (1978) stresses that the unique feature of feedback is that "the information provided is completely personalized, which should make that information both command more attention and convey the nature of the current incentive structure more effectively" (p. 12). Water users already receive feedback in the form of the bill but the bill comes too infrequently to provide effective feedback. Even if more specific (dollars and cents figures) and more frequent information is given to the consumer, it is not clear that this information will provide a long-term incentive for water conservation. Water meters can provide feedback if the customer has an accessible meter, knows how to read the meter, is motivated to take regular readings, and knows how to interpret the readings.

To date no significant studies on feedback and water conservation have been published and the research on feedback and energy conservation raises more questions than it answers. Feedback seems to encourage conservation on a short-term basis, but it remains to be determined how long feedback continues to provide an incentive for conservation. The research on feedback and financial incentives indicates that more incentive than just the savings on the monthly bill may be required. The relationship between goal setting and feedback needs to be further explored -- it is not clear whether goal setting is an inherent part of feedback or if it should be dealt with separately.

In summary, feedback appears to be a promising incentive, but the issues mentioned above need to be studied further and feedback needs to be examined specifically in relation to water conservation.

## 4. INCENTIVES IN MASS-METERED RESIDENCES

Several studies have looked at possible incentives in mass-metered residences. In these situations, individuals do not receive the feedback on consumption rates which is normally provided by the bill or the water meter. Also by not paying directly for the water or energy consumed these individuals do not experience the consequences of consumption. The studies reported here are all from the area of energy conservation.

Heberlein (1975) distributed informational material on electrical energy usage to apartment dwellers. One group received information designed to encourage increased consumption; another group received information designed to discourage consumption; a third group served as a control. Energy usage did not change as a result of the informational material.

Newsom and Makranczy (1978) looked at the use of information and feedback to encourage energy conservation by students living in nine university dormitories. "At the end of a baseline period, residents of three dormitories were mailed a flyer containing the average monthly cost of electricity to the university, ways to reduce electricity consumption, and a request for students to use less electricity. Residents of three other dorms were mailed an identical flyer and weekly feedback sheets containing the amount of electicity consumed in their dormitory, the percent above or below baseline consumption, and the amount of increased cost or savings to the university. The three remaining dormitories served as controls..." (p. 219). The results "suggested that conservation information alone and information plus feedback are ineffective in modifying electricity consumption of residents in mass-metered dormitory complexes" (p. 219).

Based on these results, the researchers decided to investigate the effects of a monetary incentive. Residents of two dorms were sent a flyer containing rules for an energy conservation contest and an announcement that each house in the winning dorm would receive $30. Residents of two other dorms received the same rules and an announcement that each house in the dorm would receive $30 which was to be raffled to an individual. Two additional dorms served as controls. Electricity consumption in the contest and contest-raffle dorms was lower than in the control dorms. The researchers continued to monitor consumption after the study was completed and found that somewhat lower consumption rates continued in the contest and contest-raffle dorms.

Winett (1978) was able to alter energy consuming behavior in classroom buildings by posting attractive signs. The signs requested a specific action -- the turning out of lights in unoccupied rooms. More general signs urging energy conserving behavior had not been effective.

These studies highlight the difficulties encountered in attempting to encourage conservation in mass-metered residences. They suggest that consumer information materials by themselves are likely to be ineffective in promoting water conservation in these residences. The Winett study does

suggest, however, that well-designed posters or signs addressing specific water consumption behavior and placed near the source of that behavior may be effective.

## 5. OTHER STUDIES ON POSSIBLE INCENTIVES

A number of other incentives have been explored in preliminary studies on energy consumption. Pallak and Cummings (1976) measured electricity and natural gas usage for three groups. The first group agreed to participate and expected to be publicly identified as attempting to conserve energy, the second group made a private commitment to the researchers, the control group was not interviewed. The public commitment group had a lower rate of increase for both natural gas and electricity consumption than did either the private commitment group or the control group. The researchers concluded that increased attention to energy use levels leads to increased conservation. This finding agrees with the feedback research where it was noted that conservation increased when the goal set required a greater commitment on the part of the consumer.

Hass and Bagley (1975) conducted a study the results of which indicated "that, although increases in the perceived likelihood of an energy shortage had no effect, increments in the perceived noxiousness or severity of an energy crisis strengthened intentions to reduce energy consumption" (p. 754). Along these same lines, Gottlieb and Matre (1976) explored energy conserving behavior as it related to people's conception of the availability of energy. The study explored the reactions of Texans to the 1974 oil embargo. The results indicated "that differences in energy conserving behavior were dependent on differences in the degree to which the energy crisis was credible and on differences in socioeconomic status. Many of those who could afford to pay the costs of higher priced energy continued their consumption patterns pretty much as before the period of shortages. Many voluntary conservation efforts were reported, but conceptions of what was normal, proper, or necessary consumption requirements seemed strongly influenced by accustomed patterns of use" (p. 428).

This finding agrees with the studies reported in Section 6 which indicate that increased price does not always provide a strong incentive for conservation.

## 6. PRICING SYSTEMS

In the past, rate structures provided a declining rate for customers with heavy demands, then a uniform rate was adopted, and now rates are moving in the direction of imposing a surcharge on heavy demand customers. These new rate structures are seen as providing an incentive for water conservation. Table 3 summarizes the variety of pricing systems currently available.

Table 3. SUMMARY OF PRICING SYSTEMS*

| Type of System | Definition and Comments | Degree of Equity | Discouragement of Waste |
|---|---|---|---|
| Metering | 1. Not generally thought of as a pricing method, it is essential to effect most pricing programs.<br>2. Installation of meters in nonmetered areas usually results in decrease in consumption of at least 25%. | Required for Equity | Yes |
| Flat Rate | 1. Usually found in unmetered areas; each customer is charged the same regardless of the amount of water used.<br>2. Sometimes the rate is varied according to the size of delivery line.<br>3. Easy for utilities to manage. | Not Equitable | No |
| Declining Block Rate | 1. Customer is charged a certain amount for an initial quantity or "block" of water. The rate for succeeding blocks decreases with each block. | Not Equitable | No |
| Uniform Rate | 1. Each unit of water costs the same. | Equitable | Minor |
| Increasing Block Rate | 1. Customer is charged a certain amount for an initial quantity or "block" of water. The rate for succeeding blocks increases with each block. | Equitable | Yes |
| Peak Load, or Seasonal Rate | 1. Customer is charged a uniform rate for a certain quantity of water. This quantity is usually based on the reduced lawn irrigation season use or on the average demands on the water distribution system.<br>2. Quantities used above the amounts determined in (1) are charged at a higher rate. | Equitable | Yes |

* Source: Water Conservation in California, Bulletin 198, State of California: Department of Water Resources, May 1976.

Metering is required for all pricing systems except a fixed charge per period (flat rate). Two rate structures are considered as discouraging waste; the increasing block rate and the peak load or seasonal rate. These rates have yet to be fully tested; they are relatively new and have been implemented on a limited basis.

## 6.1 METERING

Individual residential water meters are relatively new. Many municipalities installed them in the 1950s and 1960s, and by 1976, over 90 percent of the municipalities in the U.S. had residential water meters for single-family homes (Milne, 1976). Apartment houses, however, rarely have individual meters. "The idea of measuring water and selling it as a commodity based upon the quantity consumed has developed slowly... The slowness in recognizing water service as a utility, like electricity or gas that can be paid for on the basis of the amount used, probably resulted from the very low cost of water" (Smith, 1956, pp. 1227-1228).

The water meter may serve as a crude feedback device, alerting the consumer to abnormally high water usage patterns. There is evidence that on a community scale the installation of individual meters has been effective in reducing water consumption. (The variations in savings reported may be accounted for by the different rate structures which were imposed following the installation of meters.)

Smith (1956) cites two examples of water consumption decreasing following the installation of meters. "When Walla Walla, Wash., was half metered, for instance, the demand was reduced 20 percent... In Plattsburgh, N.Y., in 1953 when the town was half metered, daily consumption had dropped... as compared to the demand 5 years before when the flat rate [fixed charge per period] was in effect. This drop...was recorded despite a normal population increase over the 5-year period" (p. 1230).

A California report (Nelson, 1977) concludes that household savings on the order of 30 percent can be achieved as a result of metering residential customers.

Hanke and Boland (1971) report on the experiences of the water utility in Boulder, Colorado. "Prior to 1961, the management of this utility relied exclusively on the augmentation of the water supply and the imposition of sprinkling restrictions on summer demands to meet anticipated 'water shortages.' In 1961, however, a major change took place. The utility, in an attempt to meet impending water shortages, looked to price as a means of managing water demands. Starting in that year, water meters were universally installed in the residential areas of the city, areas previously billed for water on a flat rate [fixed charge per period] basis" (p. 6798). A uniform commodity charge was adopted.

"Detailed analysis of both domestic and sprinkling water use for all meter routes studied gave the same results -- a large and consistent drop in water use immediately following the adoption of a metered rate.

Average domestic use fell 36 percent; sprinkling use, corrected for weather conditions, dropped more than 50 percent. In every case the change was persistent -- no significant recovery was noted" (p. 681). This persistent change was evident during six years after metering was installed.

The authors attributed this persistence to permanent changes such as leak repairs and also to changes in water consuming habits, particularly in the use of water for lawn sprinkling. As a part of the water demand analysis, 180 individuals living in the study area were interviewed about their response to the price change. Fifty-one percent responded that they had increased their conservation efforts when the meters were installed and they had further intensified their efforts following the first year.

Hanke and Flack (1968) observe that "negative effects from the consumption of additional units of water will be the only significant incentive to halt the use of more water" (p. 1339). They go on to state that metering provides the negative effect of increased cost for increased use, but at the same time provides the benefit of allowing the consumer to choose whether or not to incur the increased cost.

In the similar area of residential energy use, more and more cases of multi-family residences converting from master to individual meters are being cited (Rhoten, 1978). A Federal Energy Administration study ("Does it pay to stay off master meters?" 1976), indicated that individuals living in apartment buildings with master meters use 35 percent more electricity than apartment dwellers who pay for their own electricity. As water becomes more scarce and costs increase, individual metering in multi-family units may provide a strong incentive for conservation.

## 6.2 INCREASING BLOCK RATE

In 1977, the Washington Suburban Sanitary Commission (WSSC) asked a Citizens Advisory Committee to explore the role of rate structures in reducing water demand (WSSC, 1977). Following the advice of the Committee, in January 1978, the Washington Suburban Sanitary Commission (WSSC) adopted a conservation-oriented water rate schedule. "The rate is of the inclining or increasing type; is based on average daily water use; and has 100 different increments of use... The rate increments were established so that those who use less water... will pay less for water and sewer service... This approach to water conservation allows for pricing to complement the water conservation device program by giving customers an incentive to purchase and install water saving devices. If the residential customer is motivated by the rate increase to install such hardware, a permanent reduction in water use is likely" (Sharpe, 1978, p. 478).

This rate structure change was accompanied by the consumer education program mentioned earlier (Section 2.2). Officials at WSSC state that conservation appears to be taking place, although they are not carefully monitoring the system to see why or where this is taking place. The new rate structure caused little initial change in customers' water bills. For this reason,

both WSSC and the Citizens' Committee stress that the new rate structure probably did not provide any real incentive for consumers to lower consumption, but instead may serve to discourage increased consumption.

## 6.3 PEAK LOAD OR SEASONAL RATE

In Dallas in the summer of 1977, a surcharge on monthly consumption was adopted for water use above a specified level for June through September. Preliminary results indicate a decline in water demand.

The Fairfax County Water Authority in Fairfax County, Virginia has also adopted a rate structure which reflects the seasonal nature of costs. Records showed that customers on the average consumed 1.3 times more water in the summer quarters than in the winter quarter. It was assumed that those customers who used more water in the summer were the same customers who were creating peak demands. An excess use charge is assessed to those customers whose consumption for both summer quarters exceeds winter quarter consumption by a factor of 1.3 (Griffith, 1977). As mentioned earlier, the effects of this and other rate changes have not been systematically evaluated.

## 6.4 PRICE AND CONSERVATION

There is evidence that in the past raising the price of water has not always been an effective means of encouraging conservation. Howe and Linaweaver (1967) noted that price changes had very little effect on indoor water consumption. Outdoor water use decreased with increasing price in the West and less so in the East. The results of a study by Primeaux and Hollman in 1974 "showed that consumers are relatively unresponsive to price differences within the price range displayed by the cities in the study group. Price can be used effectively as a revenue raising device but probably ineffectively as a rationing device within the current range of prices" (p. R-144). (The study was conducted in northern Mississippi; prices for mean levels of consumption ranged from $.30 to $1.65 per 1,000 gallons.) The metering studies cited in Section 6.1 would seem to contradict these findings and more information is needed on why this is true. It may be that the meter serves as a feedback device, allowing the consumer to monitor and adjust his consumption, whereas a rate increase is not accompanied by enough information to allow the consumer to modify consumption.

Finally, in considering rate changes, utilities must deal with the issue faced by Marin County and more recently by the Washington Suburban Sanitary Commission (WSSC). In Marin County, conservation was so successful that income fell off and the utility was forced to raise its rates in order to obtain enough revenue to cover expenses. WSSC faced a similar situation although an unusually wet summer was a major factor contributing to decreased revenues. Both incidents received wide-spread publicity as indications of the consumer being penalized for practicing water conservation. Utilities urgently need to respond to these concerns.

John Nelson, General Manager of the North Marin County Water District, indicated one way in which this could be handled. When the drought struck, North Marin added a drought surcharge onto existing water rates. This surcharge was implemented with the understanding that it would be removed on a specific date. Nelson feels that this system allowed the utility to meet expenses, while at the same time maintaining public trust (personal communication, October 1979).

Another possible means of dealing with this issue might be to emphasize that although conservation may cause short-term rate increases, in the long-term it should have a favorable effect on rates. Kudrna and Injerd (1979) stress this point, "over the long term... the economic impact of conservation will lower the unit cost of water because the capital costs of new and/or expanded supply and treatment facilities will be less" (p. 11).

As this overview indicates, the issue of conservation and rate structure is a complicated one requiring interaction and understanding between the customer and the utility company.

## 7. SUMMARY AND CONCLUSIONS

In summary, how can individuals be encouraged to save water? The incentives discussed in this report address two general motivations. The first assumes that individuals are beginning to develop a "conservation ethic" concerning the use of natural resources in general and water in particular. The second suggests that consumers will conserve water in order to save money.

Consumer education and information programs generally focus on encouraging a conservation ethic. The 1960s witnessed the beginning of an awareness of the need to protect and conserve non-renewable natural resources. The recent drought in northern California heightened awareness of water as a possible scarce resource. Many areas of the country, however, have not directly experienced water shortages and individuals have not recognized the impact of supply, storage, and treatment limitations. The consumer programs discussed in this report encourage water conservation by providing material on water conservation devices and tips on water conservation practices.

The feedback techniques and rate structures reviewed in this report rely to a large extent on financial incentives to encourage conservation. Some consumer materials also stress the financial advantages of water conservation. Increasingly, financial incentives are being related to the cost of energy. Stressing the relationship between water conservation and reduced water bills can, however, create problems. Water utilities are faced with certain fixed costs and an effective conservation effort can reduce revenues and possibly force a rate increase in the short run. This issue is receiving increasing public attention and must be dealt with so that it does not become a disincentive for conservation.

Even a direct appeal to a conservation ethic or to the financial advantages of water conservation has not always proven to be an effective incentive for water conservation. As with energy conservation, utilities, government agencies, and consumer groups face a difficult problem in motivating individuals to conserve water when there is not an immediate crisis.

The literature review strongly indicates the need for further research. Utility companies, government agencies, and consumer and environmental groups are all developing and distributing consumer information and education materials on water conservation. The effects of these materials have not been systematically studied. In fact, some of the energy conservation literature has indicated that informational material may not be an effective means of encouraging conservation (see Section 4). John Nelson, General Manager, North Marin County Water District, feels that if the consumer receives too much information (such as conservation material with each quarterly bill), the information will tend to be treated as unimportant. Many of the individuals interviewed at utility companies in California and at the California Department of Water Resources stressed the need to tie water conservation materials to energy conservation. These individuals felt that consumers are just now beginning to respond to energy conservation and to emphasize water conservation as a totally separate area would only lead to feelings of frustration and confusion. Before further major efforts are undertaken in consumer education some of these areas need to be considered.

Feedback has shown promise in the area of energy conservation, although a number of questions remain to be answered. Feedback may also prove to be an effective means of encouraging water conservation, but research needs to be undertaken which specifically addresses feedback as a water conservation technique.

In both the area of consumer materials and feedback devices much of the available information relates to energy conservation. There is an urgent need to explore the relationship between energy and water conservation to determine how much of the energy experience is relevant to water conservation and to delineate those areas where research specific to water conservation needs to be conducted.

Studies have shown that the installation of individual water meters reduces residential consumption. There, however, has not been research to determine the possibilities of using the water meter as a feedback device. Research is needed to explore which types of meters are most easily read and understood by consumers, and to consider possible locations for the meters to enhance their accessibility.

Utility companies have recently begun to implement new "conservation" rate structures. The effects of these structures on consumer consumption should be monitored over an extended period of time.

Encouraging energy conservation has not been an easy task and from all indications the water conservation area will be no different. It is

important to build on available energy information, but at the same time it is equally important to pursue areas specifically related to water consumption and the possibilities for conservation.

## 8. REFERENCES AND BIBLIOGRAPHY

This Section is subdivided. The first division lists general references followed by a separate subdivision listing references for each Section of the report.

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